Comparison of seismic ground motions in Mexico City due to damaging earthquakes applying Seismograms Analyzer-e

Armando Aguilar-Meléndez*†, Josep De la Puente*, Héctor Rodríguez-Lozoya‡ Marisol Monterrubio-Velasco*
*Barcelona Supercomputing Center, Barcelona, Spain
†Universidad Veracruzana, Poza Rica, Mexico
‡Universidad Autónoma de Sinaloa, Culiacán, Mexico
E-mail: {armando.aguilar, josep.delapuente, marisol.monterrubio}@bsc.es

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I. Introduction

Earthquakes are one of the natural phenomena that eventually can trigger damage to cities depending on diverse factors as the occurrence site, the size, duration of the earthquake, etcetera. The released energy during an earthquake is partially dissipated by seismic waves. The seismic waves that are triggered by an earthquake are unique. In other words, there are not two earthquakes that have triggered exactly the same seismic waves. The analysis of the seismic records is an important source to obtain valuable information about both the features of the seismic waves on a site and the characteristics of the earthquake that triggered these seismic waves. In the present document, we described some relevant aspects of the analysis of seismic records that we processed and analyzed applying the computer code Seismograms Analyzer-e (see Figure 1).

II. Seismic Ground Motions in Mexico City

Table I shows basic data about two earthquakes that occurred on September 19 in the years 1985 and 2017. Both earthquakes have significant differences in the magnitude and in the distance from the epicenter to Mexico City. Unfortunately, in both earthquakes, some buildings in Mexico City had a partial or total collapse and as a consequence, some people died.

TABLE I. Main data of two earthquakes that triggered significant damage in buildings of Mexico City [1] [2] [3]

Data	Michoacan Earthquake	Puebla Earthquake
Date	Sept,19,1985	Sept,19,2017
Site of occurrence	Coast of Michoacan	Limits Puebla
Magnitude	8.1	7.1
Depth	27.9 km	57.0 km
Distance from the epicenter to the Mexico City station	419.5 km	116.4 km

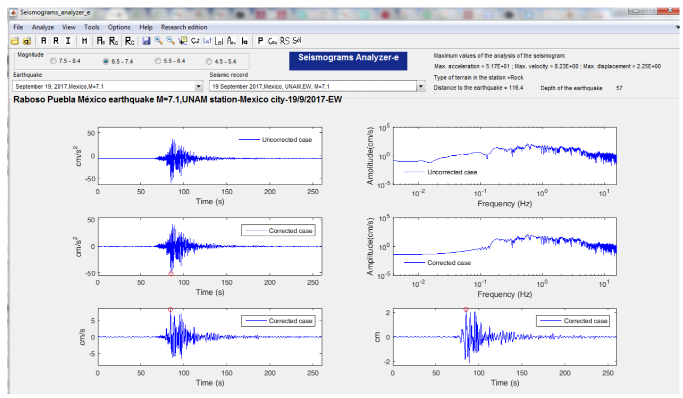

Fig. 1. Main screen of Seismograms Analyzer-e [4] [5].

A. The Michoacán, Mexico earthquake of September 19, 1985 (Ms = 8.1)

The Michoacán earthquake of September 19, 1985, generated seismic waves that in a rock site of Mexico city triggered a peak ground acceleration (PGA) about 31 cm/s^2 in the North-South component, and about 33.8 cm/s^2 in the East-West component (Figure 2). In this earthquake, the distance from the epicenter to the seismic station in Mexico City was of 419.5 km.

B. The Puebla, Mexico earthquake of September 19, 2017 (Mw = 7.1)

The Puebla earthquake of September 19, 2017, generated seismic waves that in a rock site of Mexico city triggered a peak ground acceleration (PGA) about 44.3 cm/s^2 in the North-South component, and about 51.70 cm/s^2 in the East-West component (Figure 3). In this other earthquake, the distance from the epicenter to the seismic station in Mexico City was of 116.4 km.

III. Response Spectrum

A seismic record can be used to determine a response spectrum that gives us information about the effects that the seismic waves recorded could have triggered on the buildings. For instance, a pseudoacceleration response spectrum shows values of pseudoacceleration that the earthquake could have

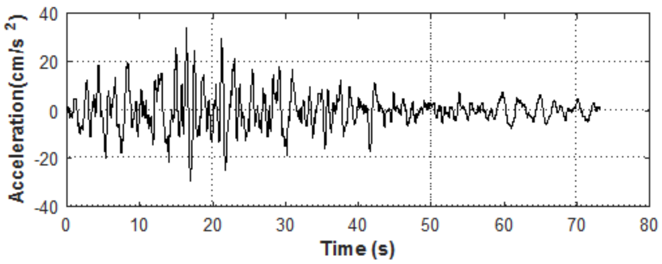

Fig. 2. Accelerogram of the component East-West of the earthquake of September 19, 1985 (Table I) recorded in a station of CU in Mexico City and processed by Seismograms Analyzer-e [4].

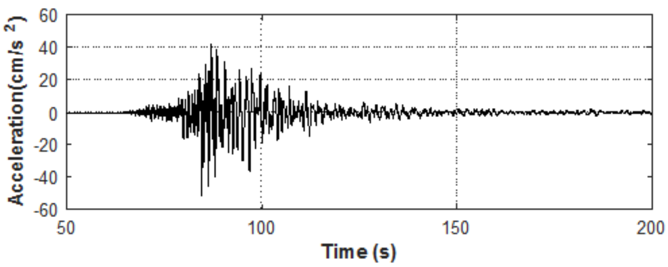

Fig. 3. Accelerogram of the component East-West of the earthquake of September 19, 2017 (Table I) recorded in a CU station of CU in Mexico City and processed by Seismograms Analyzer-e [4].

generated in the roof floor of different buildings depending on their structural period.

Figure 4 and Figure 5 show the response spectra that were determined with the acceleration data obtained in a seismic station located in the National Autonomous University of Mexico in Mexico City during the two earthquakes of Table I. According to the response spectrum of Figure 4, in the roof floor of a building with a structural period of 0.5 s (as a reference some buildings of reinforced concrete about 5 levels have a structural period near to 0.5 s) the maximum value of pseudoacceleration was of 51 cm/s^2 during the Michoacan earthquake, but of 102 cm/s^2 during the Puebla earthquake. Similarly, according to the response spectrum of Figure 5, in the roof floor of a building with a structural period of 0.5 s the maximum value of pseudoacceleration was of 60 cm/s^2 during the Michoacan earthquake but of 161 cm/s^2 during the Puebla earthquake. Therefore, it is possible to identify that the recent earthquake of Puebla generated seismic waves that in some cases triggered higher values of pseudoacceleration that the values that were triggered by the seismic waves due to the Michoacan earthquake.The high values of pseudoacceleration triggered during the Puebla earthquake are a part of the factors that explain why some buildings of Mexico City suffered partial or total collapse [3] .

The analysis that was summarized in the present work is an example of the type of analysis that it is possible to do with the support of Seismograms Analyzer-e [4]. Therefore, we believe that this kind of software must be widely sharing to contribute to that more people can be able to do these types of analysis before taking decisions about existing buildings or new buildings, in order to reduce the seismic risk of buildings.

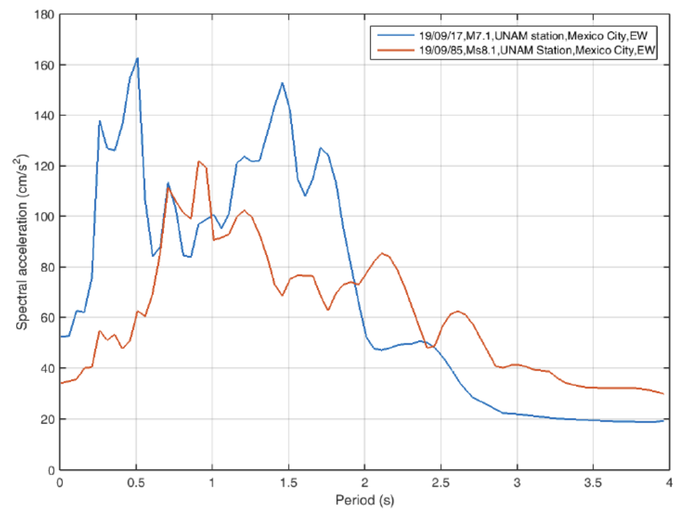

Fig. 4. Response spectra of pseudoaccelerations determined by Seismograms Analyzer-e [4] for the component North-South of the two earthquakes that occurred in the same day (September 19), but in different years (1985 and 2017) (Table I). The seismic records were obtained in a rock site of Mexico City.

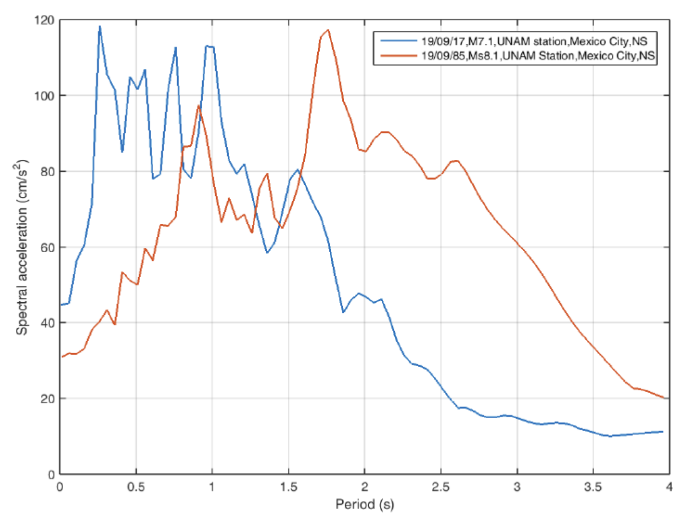

Fig. 5. Response spectra of pseudoaccelerations determined by Seismograms Analyzer-e [4] for the component East-West of the two earthquakes that occurred in the se day (September 19), but in different years (1985 and 2017) (Table I). The seismic records were obtained in a rock site of Mexico City.

IV. Conclusion

According to the results that we showed in the present document, we can to affirm that the significant damage in buildings of Mexico City during the recent earthquake (09/19/2017) was due to the combination of high values of PGA with high values of seismic vulnerability of the buildings that suffered significant damage. For instance, about the values of PGA, it is possible to highlight that the highest value of PGA that was recorded in a rock site of Mexico City during the 2017 earthquake was 53 percent greater than the value of PGA that was recorded in the same site but during the earthquake of 1985.

The analysis of seismic records is a valuable procedure to know features of earthquakes and their effect on buildings. This type of analysis can be appropriately done applying the software Seismograms Analyzer-e (SA-e) [4].

V. Acknowledgment

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Armando Aguilar Armando Aguilar is a Posdoctoral Researcher Conacyt-BSC in the CASE Department. He is mainly interested in earthquake engineering, seismic risk, seismic hazard and seismic vulnerability.

Josep De la Puente received his PhD in the Ludwing Maxmillian University in 2007. His main topic research is about computational seismology. Currently, he is the manager of the geosciences application group of the Barcelona Supercomputing Center.

Marisol Monterrubio-Velasco received her PhD from the University Politcnica de Catalunya (Spain) and was a postdoctoral researcher at Geosciences center, UNAM. At present she is postdoc in the Barcelona Supercomputing Center. Her research interests focus on computational physics, statistical analysis and numerical simulation applied to Earth phenomena (fractal structures, earthquakes behavior, statistical analysis)

Héctor Rodríguez-Lozoya received his PhD degree in Seismology from the CICESE, Mexico. Currently he is a full time Professor in the Faculty of Engineering at the Autonomous University of Sinaloa.